

LISTING OF CLAIMS

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Claim 1 (Previously amended): In a multicarrier communication system in which a signal to be transmitted comprises data bits to be converted into a symbol modulated by each subcarrier of the signal prior to transmission on a channel, a method for minimizing a peak to average power ratio while minimizing introduction of errors into the signal to be transmitted, comprising:

        sampling the symbols to be transmitted of a frame;  
        compare magnitudes of the samples of the frame to a predetermined threshold to  
                determine whether sample magnitudes in the frame violate the  
                predetermined threshold, the predetermined threshold being selectable to  
                control the number of samples violating the threshold;  
        responsive to determining a sample magnitude does violate the predetermined  
                threshold, applying a differentiable penalty function to the samples having  
                magnitudes exceeding the predetermined threshold;  
        computing a net penalty function value, the net penalty function value responsive  
                to the individual penalty function values computed for the samples having  
                magnitudes exceeding the predetermined threshold;  
        computing a gradient vector responsive to the net penalty function value;  
        determining a direction of the gradient vector;  
        determining an upper limit correction value for each symbol, the upper limit  
                correction value being selectable to control an amount of signal to noise  
                ratio deterioration;

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applying a correction to the symbols to be transmitted in a direction opposite to the direction of the gradient vector, the magnitude of the correction not exceeding the determined correction values for each symbol; and transmitting the corrected symbols to the channel.

Claim 2 (Previously amended): The method of claim 1 wherein determining an upper limit correction value for each symbol, further comprises:

computing an interpoint distance between symbols;  
selecting a correction value for a symbol as a value less than the interpoint distance to ensure that the symbol is not mistaken for other symbols.

Claim 3 (Original): The method of claim 1 wherein applying a differentiable penalty function to the samples having magnitudes exceeding the predetermined threshold comprises:  
applying the function:

$$h(x[k]) = \begin{cases} (x[k] - T)^{2m} & \text{if } x[k] > T \\ 0 & \text{if } |x[k]| \leq T \\ (x[k] + T)^{2m} & \text{if } x[k] < -T \end{cases}$$

where m is a positive integer that decides the severity of penalty, T is the predetermined threshold, x is the frame of data symbols expressed by:  $X = (r_0, r_1 \exp(j\theta_1), r_2 \exp(j\theta_2), \dots, r_{N/2-1} \exp(j\theta_{N/2-1}), r_{N/2})$ , where  $r_i$  and  $\theta_i$  denote the magnitude and phase of symbol in channel i, and k is the number of the symbol.

Claim 4 (Original): The method of claim 3 wherein the net penalty function comprises:

$$f(x) = \sum_{k=0}^{N-1} h(x[k])$$

Claim 5 (Original): The method of claim 4, wherein the gradient vector is computed as:

$$\begin{aligned} \frac{\partial f}{\partial r_i} &= \sum_{k=0}^{N-1} \frac{dh(x[k])}{dx[k]} \cos\left(\frac{2\pi ki}{N} + \theta_i\right); i \in \{1, \dots, N/2 - 1\} \\ \frac{\partial f}{\partial r_0} &= \sum_{k=0}^{N-1} \frac{dh(x[k])}{dx[k]}; \frac{\partial f}{\partial r_{N/2}} = \sum_{k=0}^{N-1} \frac{dh(x[k])}{dx[k]} \cos(\pi k) \\ \frac{\partial f}{\partial \theta_i} &= -r_i \sum_{k=0}^{N-1} \frac{dh(x[k])}{dx[k]} \sin\left(\frac{2\pi ki}{N} + \theta_i\right); i \in \{1, \dots, N/2 - 1\} \end{aligned}$$

Claim 6 (Original): The method of claim 1 wherein the gradient vector is computed only as a function of the magnitude of the sample values.

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Claim 7 (Original): The method of claim 1 wherein computing a net penalty function value comprises adding together the individual penalty function values computed for the samples having magnitudes exceeding the predetermined threshold to generate the net penalty function value.

Claim 8 (Cancelled)

Claim 9 (Currently amended): ~~In a multicarrier communication system in which a signal to be transmitted comprises data bits to be converted into a symbol modulated by each subcarrier of the signal prior to transmission on a channel, for a signal having a single peak in a frame, a method for minimizing a peak to average power ratio while minimizing introduction of errors into the signal to be transmitted, comprising: The~~

method of claim 813 wherein computing a peak reduction kernel responsive to the upper  
limit correction values comprises

~~sampling the symbols to be transmitted of the frame;~~

~~comparing magnitudes of the samples of the frame to a predetermined  
threshold to determine whether sample magnitudes in the frame  
violate the predetermined threshold, the predetermined threshold  
being selectable to control the number of samples violating the  
threshold;~~

~~determining an upper limit correction value for each symbol, the upper  
limit correction value being selectable to control an amount of  
signal to noise ratio deterioration;~~

~~computing a peak reduction kernel responsive to the upper limit correction  
values further comprises~~

~~determining a phase component and an amplitude component of the upper  
limit correction values; and~~

~~setting the phase component of the upper limit correction values to zero to  
ensure that the peak reduction kernel has its peak value at the first  
sample of the frame;~~

~~responsive to determining a sample magnitude does violate the  
predetermined threshold, applying the peak reduction kernel to the  
sample to reduce the peak of the frame; and  
transmitting the modified symbol.~~

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Claim 10 (Currently amended): The method of claim 913 wherein applying the peak reduction kernel to the sample to reduce the peak of the sample comprises:

rotating the peak reduction kernel by an amount to ensure a peak of the peak reduction kernel coincides with a peak of the frame;  
determining whether the peak of the peak reduction kernel has a sign equal to a sign of the peak of the frame;  
responsive to the signs of the peaks of the peak reduction kernel and the frame being equal, multiplying the peak reduction kernel by minus one; and  
adding the peak reduction kernel to the samples to reduce the peak of the frame.

Claim 11 (Currently amended): The method of claim 913 in a system in which more than one peak may be present per frame, comprising the steps of:

responsive to determining that a sample magnitude exceeds the predetermined threshold, applying the peak kernel to the sample, wherein the peak kernel applied for each sample has a magnitude scaled relative to an extent the sample magnitude exceeds the predetermined threshold.

Claim 12 (Original): The method of claim 11 wherein the scaling factors are chosen to ensure a sum of the magnitudes of the kernels applied is equal to one.

Claim 13 (Reinstated-formerly Claim 8): In a multicarrier communication system in which a signal to be transmitted comprises data bits to be converted into a symbol modulated by each subcarrier of the signal prior to transmission on a channel, for a signal having a single peak in a frame, a method for minimizing a peak to average power ratio while minimizing introduction of errors into the signal to be transmitted:

sampling the symbols to be transmitted of the frame;

comparing magnitudes of the samples of the frame to a predetermined threshold to determine whether sample magnitudes in the frame violate the predetermined threshold, the predetermined threshold being selectable to control the number of samples violating the threshold;

determining an upper limit correction value for each symbol, the upper limit correction value being selectable to control an amount of signal to noise ratio deterioration;

computing a peak reduction kernel responsive to the upper limit correction values;

responsive to determining a sample magnitude does violate the predetermined threshold, applying the peak reduction kernel to the sample to reduce the peak of the frame; and

transmitting the modified symbol.